MAY 1 1909

JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

Entered as second-class matter May 7, 1906, at the Post Office at San Francisco, Cal., under the Act of Congress March 3, 1879

VOL. XXII NO. 18 | SAN FRANCISCO, MAY 1, 1909 | PER COPY, 10 CENTS

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POWER AND GAS
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VOLUME XXII. SAN FRANCISCO, MAY 1, 1909. NUMBER 18

ON LIGHTNING PROTECTION.[1]

BY A. G. JONES.

The history of lightning protection in the electrical field began with telegraph circuits. A careful analysis was made of these conditions and experimental demonstrations were given by Sir Oliver Lodge in England. The problem was comparatively simple. On the telegraph circuits the potential employed and the amount of energy in their batteries were too small to cause or maintain an arc from line to line or from line to ground. Lightning was taken from these lines by the insertion of a small gap in the wire leading from each line to the earth. This simple lightning arrester could be designed without any consideration of the natural frequencies of the lightning, duration of the lightning stroke, the potential of the electrical generator or the amount of energy that might be concentrated in the lightning arrester during the discharge.

Before entering into a general discussion of the principal types of lightning arresters, it will not be amiss to explain more definitely the meaning of the word "lightning," as it is applied at the present time. Formerly the word "lightning" was used to denote atmospheric electrical disturbances only, but with the advent of high voltage transmission systems, the word has been used in a broader sense, and is now generally accepted as denoting all phenomena due to abnormal voltages and abnormal frequencies which may be caused from one or a combination of several different sources.

Direct Lightning Stroke to Ground, Tonopah, Nevada.

[1]Paper read before San Francisco Section of the American Institute of Electrical Engineers, March 26, 1909.

In general, abnormal stresses may be subdivided into three general classes:

1. Steady stress or gradual charge.
2. Impulse or traveling wave.
3. Standing wave or oscillation.

A steady stress or gradual charge may be caused from rain, snow or fog being driven across the transmission wires by high wind; from a passing cloud which may be charged to a very high potential above earth; by line traversing territory of widely varying altitudes.

The impulse or traveling wave is due to a direct stroke of atmospheric lightning; to the inductive effect of a discharge from cloud to cloud, or from cloud to earth; to arcing grounds, which are very serious; and to sudden changes of load, switching, etc.

The standing wave or oscillation may be of most any frequency, the high frequency usually giving rise to the lower frequencies which cause surges that represent the generated power of the circuit, the frequency of which is usually in the neighborhood of the fundamental or natural frequency of the system. This oscillating power is represented by two components, one being the electro-magnetic energy which is equal to the product of one-half the inductance of the circuit times the square of the instantaneous value of the current, the other being the electrostatic energy, which is equal to one-half the capacity times the square of the instantaneous voltage. It is the electro-magnetic energy which invariably causes the most disastrous results, the maximum effects being dependent upon the short circuit value of the current.

In speaking of standing waves or oscillations, the analogy of a vibrating pendulum may be used, the shorter the pendulum the more rapid the vibrations, as is also the case with transmission lines, the shorter the line in which the disturbance takes place, the higher will be the frequency. It is, therefore, in long lines that low frequency surges are particularly liable to take place, therefore they are subject to the most disastrous results. Arcing grounds and discharges through defective joints in underground cable systems are particularly liable to cause low frequency surges, and every effort should be made to guard against such disturbances.

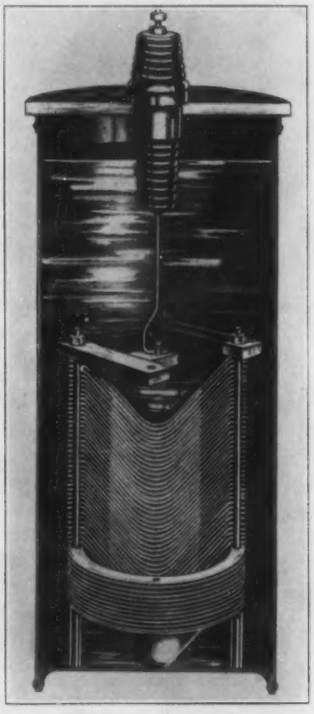
When an attempt was first made to apply the lightning arrester to power lines, it was found that the single gap was insufficient to extinguish the dynamic current from the generator which followed the spark of the lightning discharge. This problem was temporarily solved in direct current circuits by putting in an electro-magnetic blow-out. This electro-magnetic blow-out is equivalent to a strong blast of air playing on the arc at right angles to it. In alternating current circuits the problem was first solved by using a number of gaps in series between brass cylinders. This arrester gave satisfaction so long as the generators were of only a few hundred kilowatts' capacity, and the voltage regulation very poor, but failed subsequently as the amount of energy to be transmitted was increased and the design of the generators improved. Such an arrester, it was found, short circuited the line during a half wave of the generator, about .001 of a second, and with generators of large capacity the amount of energy given off in the lightning arrester during this brief period was enough to throw the molten metal from cylinder to cylinder and thus put the arrester permanently out of operation. Different electrical companies differed in their practice about this time. One year one company advised the use of the arrester without series resistance and another company talked of the advantages of the limiting series resistance. The next year the two companies would reverse their policies. On the face of it the desideratum seemed to be impossible to attain. It is desired to have practically zero resistance between line and ground when the lightning discharge takes place, but a comparatively high resistance when the dynamic follows. Since potential is nearly of the same nature whether generated by a machine or by the clouds and both potentials occur simultaneously over the arrester, how is it possible to design an arrester so that the series resistance will always be effective in holding back the dynamic current and yet does not lie in the path of the lightning discharge?

The basic principle of the multigap arrester has been known for many years under the name of "non-arcing quality of metals." More recently it was discovered that the so-called nonarcing quality of the metal was rectifying, that is to say, if an arc was started in one direction it could be easily maintained at a comparatively low voltage, about 20 to 30 volts, but if the potential reversed it would require several thousand volts to re-establish the arc with the current in the opposite direction. During the past three years the variation in the design of lightning arresters has consisted in using a greater or less number of gaps in series and in parallel with resistance. It is evident that any series resistance placed in the lightning arrester circuit will be beneficial in limiting the dynamic flow of the current when the arc is established by the discharge of lightning through the arrester. On the other hand, this same resistance will also limit the discharge of the lightning current, or in other words, it will prevent the free discharge of the quantity of induced electricity on the line and will therefore prevent the rapid decrease of potential of the lightning. Since all lightning strokes do not cause a heavy discharge, it was found that lightning arresters with series resistance gave as a rule fairly good satisfaction, but occasionally a very heavy stroke of lightning would enter the station and the lightning arrester would be ineffective.

Two general schemes for solving the arrester problem by the multi-gap principle have been developed, one of which uses a fixed resistance in series with a number of gaps, depending upon the voltage of the circuit, and also a shunt resistance around about half of these gaps. The other uses a definite number of multi-gaps between line and ground and shunts these gaps at different points by three graded resistances in such a way as to give selective paths for the lightning. Light strokes can be taken care of by the high resistance shunt, heavy strokes by the low resistance shunt, medium strokes by the medium resistance shunt, and extraordinary heavy strokes pass directly to the ground without intervention of resistance. By the use of these graded shunt resistances the arrester is rendered sensitive to a wider range of frequency of lightning. It is a well known fact that the higher the frequency of the

lightning the more easily will it discharge over the multi-gaps. These arresters are now in their second year with no suggestions regarding their improvements. When the multi-gap arrester begins to discharge there is a successive action of the different parts. This action is best described as "breaking back action" on low frequency surges.

In this manner the discharge of lightning can find its way to earth without passing through series resistance. On the other hand, the dynamic at generator frequency is extinguished immediately by the shunting action of the parallel resistance. The shunt resistances are so adjusted to the number of parallel gaps that nothing but high frequency discharges can be maintained across the parallel gaps.

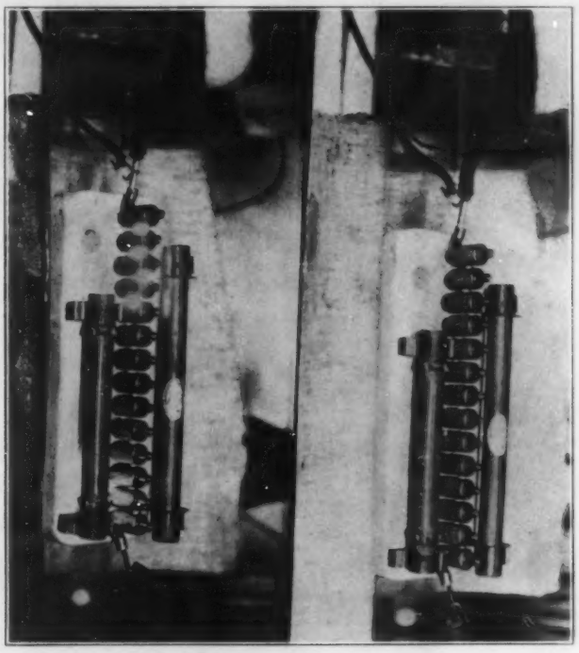


Cross Section of Single Leg Aluminum Lightning Arrester for 20,000 Volts.

The multi-gap arrester has its limitations. It is particularly useful to discharge transitory lightning such as induced by thunder clouds. Occasionally, however, an accidental arc will take place on the circuit which will cause recurrent surges at both the making and breaking of this arc.

It has developed that internal surges in a transmission system due to some accidental condition, such for example as a broken transmission wire or a wire grounded against a tree or pole, will cause abnormal rises in electric pressure on the circuit almost as high as those caused by cloud lightning and far worse to suppress because these potential rises are recurrent. It was found that the multi-gap arrester would discharge these recurrent surges, but since it is impossible to design an economical resistance for a lightning arrester which will carry the dynamic current continuously, the arrester resistances were destroyed under these particular conditions. These recurrent surges, or they may be called continual lightning, introduce a new factor in the lightning arrester problem. Research has been made for years to discover some substance which would have a property like that of a safety valve on the steam boiler. The action of the steam safety valve, as every one knows, is to relieve the pressure in the boiler as soon as it rises to a fixed value, according to the strength of the boiler. Below that value there is no discharge.

In electrical circuits it has been found through the investigation of Prof. E. E. F. Creighton, that the aluminum condenser will perform the same function to the electrical circuit that the steam safety valve does to the boiler. The aluminum cell connected between line and ground on the electrical circuit corresponds to a leaky safety valve. Under normal pressure

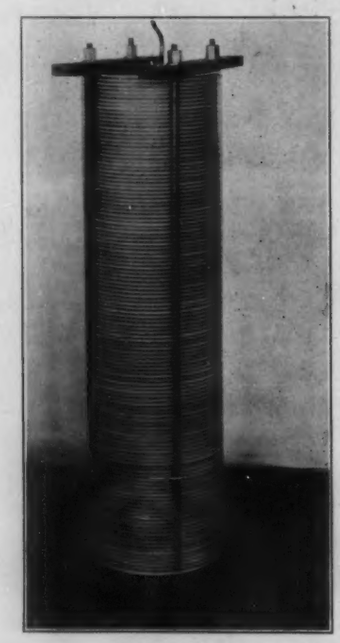


2300 Volt Arrester in Actual Operation. The upper unit is discharging high frequency current approximately of the same volume between each of the gaps, the little white dots between the cylinders indicating the arc. On the lower unit the current in the gaps shunted by the low resistance is static, while that in the remainder of the gaps is dynamic, thus indicating the flow of current of low frequency, and shows admirably the selective path employed in the design of the multigap arrester.

of the circuit there is a slight leakage of current all the time. When, however, the pressure rises to about 35 per cent above the normal generator pressure the electrical valve in the condenser opens up and allows the current to flow freely from the line to the ground, and closes up instantly when the pressure returns to its normal value. Since there is practically no discharge at normal pressure no appreciable energy is taken from the generator, but all the energy of the lightning stroke can be easily absorbed. Since this arrester can be designed to be connected between line and ground for any desired length of time, it takes care of the recurrent surges which have already been mentioned. The introduction of this lightning arrester was delayed by the natural antipathy to anything wet about the electrical station and by the long exhaustive tests required to determine the choice of electrolyte for the cell.

The aluminum cell consists of two aluminum

plates, immersed in a suitable electrolyte. On the surface of the plates is formed a film of high resistance, the film being deposited by a special electro-chemical process. This film has very peculiar characteristics, and up to a certain "critical" voltage has a very high dielectric strength. This critical voltage is subject to either of two conditions, and we may speak of the film as having a "temporary critical voltage" and a "permanent critical voltage." When a cell is connected in a circuit and the voltage gradually increased, there will be a slight flow of current due to leakage until the value of approximately 420 volts is reached, at which point the film will break down uniformly over its entire surface and allow current to flow in proportion to the impressed voltage. This value of approximately 420 volts is called the permanent critical voltage. On the other hand, suppose we have a cell which has been



Stack of Cones in 60,000 Volt Arrester.

connected to a circuit of 350 volts for a considerable length of time. The film will adjust itself so that it will allow a very slight leakage current to flow at this value. If, however, the voltage is suddenly raised to 400, there will be a momentary rush of current greatly in excess of the leakage value. The current will almost immediately die down to its normal leakage value at 400 volts. In such a case as this the value of 350 volts may be termed the temporary critical voltage.

The aluminum arrester designed for use on direct current has a discharge rate of .001 ampere at 600 volts and a discharge rate of 1100 amperes at 1200 volts. That is to say, that the discharge rate at double voltage is a million times as great as the discharge rate at normal voltage. This arrester operates without a series gap and therefore begins to discharge the instant the voltage begins to rise above normal.

On alternating current circuits of higher voltages, especially on overhead lines, the form of aluminum arrester is changed to meet the demand of these new conditions. As explained above, the critical voltage of an aluminum cell is approximately 420 volts, therefore in designing an arrester for high voltages, it is necessary to place a number of these cells in series, the number being so proportioned that the critical voltage per cell will not be exceeded. This is accomplished by forming the aluminum plates in the shape of cones which are mounted one above the other, being separated by suitable insulating spacers, and held in position by rigid braces. The electrolyte is placed in

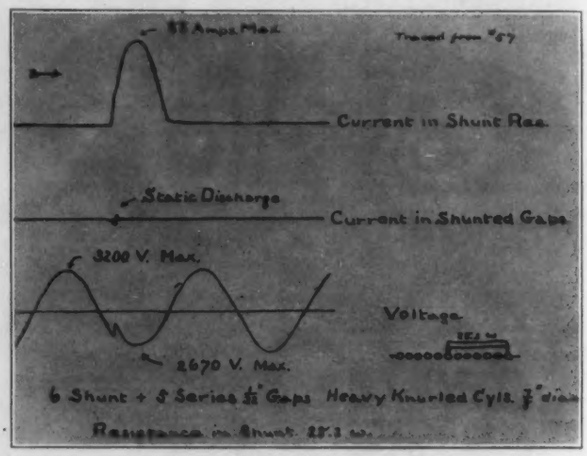
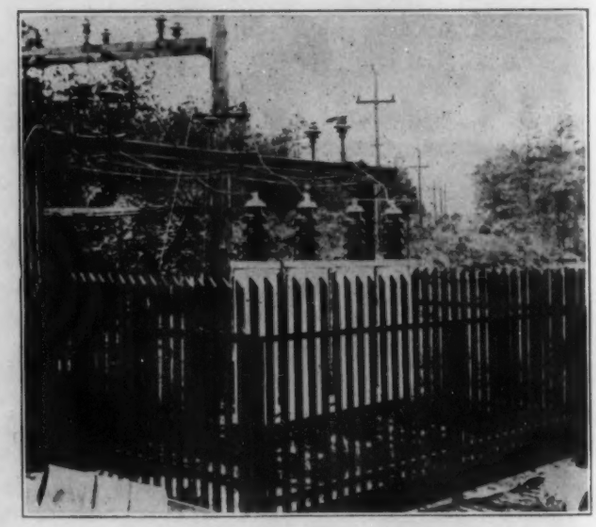


Fig. 11. Oscillogram of action in the gaps during the period of discharge.

the cells formed by the cones and an amount which will only partially fill the cells is used. The stack of cones containing the electrolyte is then immersed in a metal tank containing transil (or insulating) oil. The oil serves the purpose of rapidly absorbing the heat from the arrester during process of continual



Aluminum Cell Lightning Arrester, Out of Doors.

discharge, and it also serves as an insulator preventing arc-overs from cones to tank. A gap is introduced in series and the arrester may then be made very compact. It is not designed to be continuously on the circuit, but may be put into continuous operation for a half hour or even more without destroying the arrester.

While it is possible to design these arresters to

be left continually on the circuit, it seems unnecessary under these circumstances and the extra cost of such an arrester is not justified. With the inverted concentric cones a very short path is formed between line and ground. The discharge rate is about 1000 amperes at double normal line voltage. The leakage current is about one ampere at sixty cycles. This current of one ampere does not represent energy directly, because the aluminum cell is a fairly good condenser and takes a leading current.

The horn type lightning arrester in many cases causes a great deal more damage than good, and as a protective device it is of little value. When placed directly between line and line, or line and ground without any series resistance, the chances are that when it is used on lines of medium and high k. w. capacity that it will short circuit the line when an arc-over takes place. Especially is this so in cases of recurrent discharges or "continual lightning." If resistance is used it limits the flow of discharge current and will not, therefore, give relief to the system. The flaming arc which results from a discharge of the horn arrester may last for several seconds and it is very essential that it should be suppressed at the end of the half cycle in which the discharge began. Under certain conditions the arc at the horn may cause much more damage than the original stroke. In other words, it might give rise to high power, low frequency surges. The horns have to be very carefully designed with regard to their shape, as the magnetic action probably has as much or more to do with the extinguishing of the arc as does the heat generated. If the horns themselves are imperfectly shaped the arc may travel downward instead of upward, thus causing it to hold and effectively short circuit the system.

On low potential circuits, say 2300 volts to 6600 volts, the dangers from recurrent surges are comparatively few, and therefore the multi-gap arrester is eminently suited. It is advisable, however, even on these circuits, to install in the central stations one aluminum arrester. Its gap should be set at a voltage somewhat under the sparking voltage of the multi-gap arrester, which is placed on the feeders, so that if recurrent surges take place on the line, the aluminum arrester will take the discharge. As a line arrester it is advisable to use the multi-gap type. On high voltages it is recommended that several aluminum arresters be used to take care of recurrent surges or continual lightning. Since the aluminum arrester will continue to discharge until the trouble is removed from the circuit, it should be installed as a continual lightning arrester, only in places where there is an attendant to note the discharges, or else the arrester should be equipped with a bell alarm which can be very easily and effectively applied so that it will notify an attendant at a distant point when a discharge is taking place, and steps can then be taken to locate and remove the trouble. When using the aluminum arrester as a line arrester or in unattended stations, the series gap should be placed at a sparking value equal to other transitory lightning arresters.

Regulation of telephone companies is provided by a bill introduced in the New York Legislature by Assemblyman Cuvillier. The bill prohibits telephone pools, trust agreements and combinations.

SMOKELESS COMBUSTION.

A bulletin on the smokeless combustion of coal in boiler plants with a chapter on central heating plants will soon be issued by the United States Geological Survey, Technologic Branch, giving in detail a study of the conditions found in industrial establishments in thirteen of the largest cities of Indiana, Illinois, Kentucky, Maryland, Michigan, Missouri, New York, Ohio and Pennsylvania, between 400 and 500 plants having been inspected. Sufficient information was collected to make the data from 284 plants of value for this report.

The bulletin, prepared by D. T. Randall and H. W. Weeks, not only shows that bituminous coals high in volatile matter can be burned without smoke, but also that large plants carrying loads that fluctuate widely, where boilers over banked fires must be put into service quickly and fires forced to the capacity of their units can be operated without producing smoke that is objectionable. Proper equipment, efficient labor and intelligent supervision are the necessary factors.

The burning of coal without smoke is a problem which concerns the government directly because of the advantages of smokeless combustion both in public buildings and on naval vessels. In addition, smoke abatement is a factor in conserving the fuel resources of the United States, hence, as a part of its general investigation of the best methods of utilizing the coals of this country, the United States Geological Survey has made extended tests to determine the conditions necessary for the smokeless combustion of bituminous coal in boiler plants.

The general conclusions of Messrs. Randall and Weeks are as follows:

Smoke prevention is possible. There are many types of furnaces and stokers that are operated smokelessly.

Credit is to be given to any one kind of apparatus only in so far as the manufacturers require that it shall be so set under boilers that the principles of combustion are respected. The value of this requirement to the average purchaser lies in the fact that he is thus reasonably certain of good installation. A good stoker or furnace poorly set is of less value than a poor stoker or furnace well set. Good installation of furnace equipment is necessary for smoke prevention.

Stokers or furnaces must be set so that combustion will be complete before the gases strike the heating surface of the boiler. When partly burned gases at a temperature of, say, 2500° F., strike the tubes of a boiler at, say, 350° F., combustion is necessarily hindered and may be entirely arrested. The length of time required for the gases to pass from the coal to the heating surface probably averages considerably less than one second, a fact which shows that the gases and air must be intimately mixed when large volumes of gas are distilled, as at times of hand firing, or the gas must be distilled uniformly, as in a mechanical stoker. By adding mixing structures to a mechanical stoker equipment both the amount of air required for combustion and the distance from the grates to the heating surface may be reduced for the same capacity developed. The necessary air supply can also be reduced by increasing the rate of combustion.

No one type of stoker is equally valuable for burning all kinds of coal. The plant which has an equipment properly designed to burn the cheapest coal available will evaporate water at the least cost.

Although hand-fired furnaces can be operated without objectionable smoke, the fireman is so variable a factor that the ultimate solution of the problem depends on the mechanical stoker—in other words, the personal element must be eliminated. There is no hand-fired furnace from which, under average conditions, as good results can be obtained as from many different patterns of mechanical stoker; and of two equipments the one which will require the less attention from the fireman gives the better results. The most economical hand-fired plants are those that approach most nearly to the continuous feed of the mechanical stoker.

The small plant is no longer dependent on hand-fired furnaces, as certain types of mechanical stokers can be installed under a guaranty of high economy, with reduction of labor for the fireman.

In short, smoke prevention is both possible and economical.

During 1904 to 1906 coals from all parts of the United States were burned at the Government Fuel Testing Plant at St. Louis, in furnaces which were in the main of the same design. Most of the tests were made on a hand-fired furnace under a Heine water-tube boiler. The lower row of tubes of the boiler supported a tile roof for the furnace, giving the gas from the coal a travel of about twelve feet before coming into contact with the boiler surface. This furnace is more favorable to complete combustion than those installed in the average plant. A number of coals were burned in this furnace with little or no smoke, but many coals could not be burned without making smoke that would violate a reasonable city ordinance when the boiler was run at or above its normal rated capacity.

In 1907, the steaming section of the St. Louis plant was moved to Norfolk, Va., where subsequent tests of this nature were made. The plant at Norfolk was equipped with two furnaces—one fired by hand and the other by a mechanical stoker.

In the course of the steaming tests some special smoke tests were made and the influence of various features in smoke production was noted. As the tests were made as far as possible under standard conditions with a minimum variation in boiler room labor the results bring out the importance of other factors such as character of fuel and furnace design.

A brief summary of the general conclusions is as follows:

A well-designed and operated furnace will burn many coals without smoke up to a certain number of pounds per hour, the rate varying with different coals, depending on their chemical composition. If more than this amount is burned, the efficiency will decrease and smoke will be made, owing to the lack of furnace capacity to supply air and mix gases.

High volatile matter in the coal gives low efficiency and vice versa. The highest efficiency was obtained when the furnace was run at low capacity. When the furnace was forced the efficiency decreased.

With a hand-fired furnace the best results were obtained when firing was done most frequently, with the smallest charge.

Small sizes of coal burned with less smoke than large sizes, but developed lower capacities.

Peat, lignite and sub-bituminous coal burned readily in the type of tile-roofed furnace used and developed the rated capacity with practically no smoke.

Coals which smoked badly gave efficiencies 3 to 5 per cent lower than the coals burning with little smoke.

Briquets were found to be an excellent form for using slack coal in a hand-fired plant. They can be burned at a fairly rapid rate of combustion with good efficiency and with practically no smoke. High-volatile coals are perhaps as valuable when briquetted as low-volatile coals.

A comparison of tests on the same coal washed and unwashed showed that under the same conditions the washed coal burned much more rapidly than the raw coal, thus developing high rated capacities. In the average hand-fired furnace washed coal burns with lower efficiency and makes more smoke than raw coal. Moreover, washed coal offers a means of running at high capacity, with good efficiency, in a well-designed furnace.

Forced draft did not burn coal any more efficiently than natural draft. It supplied enough air for high rates for combustion, but as the capacity of the boiler increased the efficiency decreased and the percentage of black smoke increased.

Most coals that do not clinker excessively can be burned with 1 to 5 per cent greater efficiency and with a smaller percentage of black smoke on a rocking grate than on a flat grate.

Air admitted freely at firing and for a short period thereafter increases efficiency and reduces smoke.

As the CO in the fuel increases the black smoke increases; the percentage of CO in the flue gas is therefore, in general, a good guide to efficient operation. However, owing to the difficulty in determining this factor, combustion cannot be regulated by it.

The simplest guide to good operation is pounds of coal burned per square foot of grate surface per hour.

None of the problems of combustion have received more experimental treatment than the burning of coal in hand-fired furnaces. Hundreds of devices for smokeless combustion have been patented but almost without exception they have proved failures. This record may be explained by the fact that many of the patentees have been unfamiliar with all the difficulties to be overcome, or have begun at the wrong end. Numerous patents cover such processes as causing the waste gases to re-enter the furnace, and schemes for collecting and burning the soot are legion. So many manufacturers who have been looking for some cheap addition to a poorly constructed furnace to make it smokeless have experienced inevitable failure that the work of educating the public to rid cities of the smoke nuisance has been hard, long, and only partly successful.

The total number of steam plants having boilers fired by hand is far greater than the total of plants with mechanical stokers, but if the comparison is based on total horsepower developed the figures show

less difference. Particularly is this true in sections of the Central West, where mechanical stokers are generally used at large plants. As a general rule, hand-fired plants do not have proper furnaces, and methods of operation are far from conducive to good combustion. Coal is usually fired in large quantities, and little opportunity is given for the air and gases to mix before the heating surface is reached and combustion is arrested. In all the hand-fired plants visited success in smoke prevention has been obtained chiefly by careful firing. The coal was thrown on often in small quantities; the fire was kept clean, enough ash to prevent the passage of air through the fire never being allowed to collect on the grate; and more air was supplied at firing than after the volatile matter had been distilled. Even with such precautions the plants might have made objectionable smoke at times but for the fact that usually some method was employed for mixing the gases and air before they reached the heating surface.

Some general conclusions from the facts set forth in the bulletin are as follows:

The flame and the distilled gases should not be allowed to come into contact with the boiler surfaces until combustion is complete.

Fire-brick furnaces of sufficient length and a continuous or nearly continuous supply of coal and air to the fire make it possible to burn most coals efficiently and without smoke.

Coals containing a large percentage of tar and heavy hydro-carbons are difficult to burn without smoke and require special furnaces and more than ordinary care in firing.

Briquets are suitable for use under power-plant conditions when burned in a reasonably good furnace at the temperatures at which such furnaces are usually operated. In such furnaces briquets generally give better results than the same coal burned raw.

In ordinary boiler furnaces only coals high in fixed carbon can be burned without smoke, except by expert firemen using more than ordinary care in firing.

Combinations of boiler-room equipment suitable for nearly all power-plant conditions can be selected, and can be operated without objectionable smoke when reasonable care is exercised.

Of the existing plants some can be remodeled to advantage. Others can not, but must continue to burn coals high in fixed carbon or to burn other coals with inefficient results, accompanied by more or less annoyance from smoke. In these cases a new, well-designed plant is the only solution of the difficulty.

Large plants are for obvious reasons usually operated more economically than small ones, and the increasing growth of central plants offers a solution of the problem of procuring heat and power at a reasonable price and without annoyance from smoke.

The increasing use of coke from by-product coke plants in sections where soft coal was previously used, the use of gas for domestic purposes, and the purchase of heat from a central plant in business and residence sections all have their influence in making possible a clean and comfortable city.

The principal use of platinum is in electric furnaces to withstand high temperatures and in electrolytic appartus to withstand chemical corrosion.

LOGARITHMIC WIRING DIAGRAM.

RICHARD C. POWELL,

Oakland Gas, Light and Heat Company.

In the solution of most engineering problems, a graphic representation in the form of a curve or set of curves is extremely advantageous from two standpoints, at least. First, space is economized; more values can be gotten from a curve than can be printed in the same space in the form of a table. Second, a curve or diagram gives, as it were, a bird's eye view of the relations between the quantities over any range desired.

Several systems and devices of plotting are available, one of these being the use of a logarithmic scale.

In the construction of the wiring diagram devised by the writer, logarithms were resorted to in order to obtain a linear relation between quantities which involve a quadratic relation when expressed in the ordinary Cartesian co-ordinates.

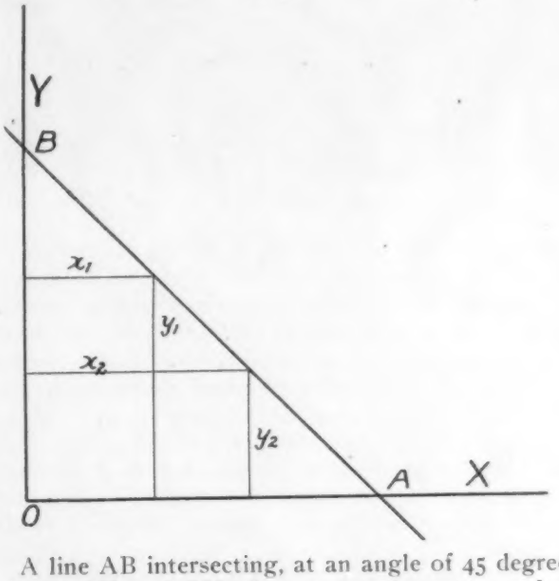
A very familiar formula for finding the drop in a copper wire is

$$V = \frac{10.7\ I\ d}{C},$$

where V = volts lost, I = the current in amperes, d = the distance in feet and C = the area, in circular mils, of the wire.

By rearranging this formula and taking logarithms, we have

$$(1)\quad \log V + \log \frac{C}{10.7} = \log I + \log d.$$



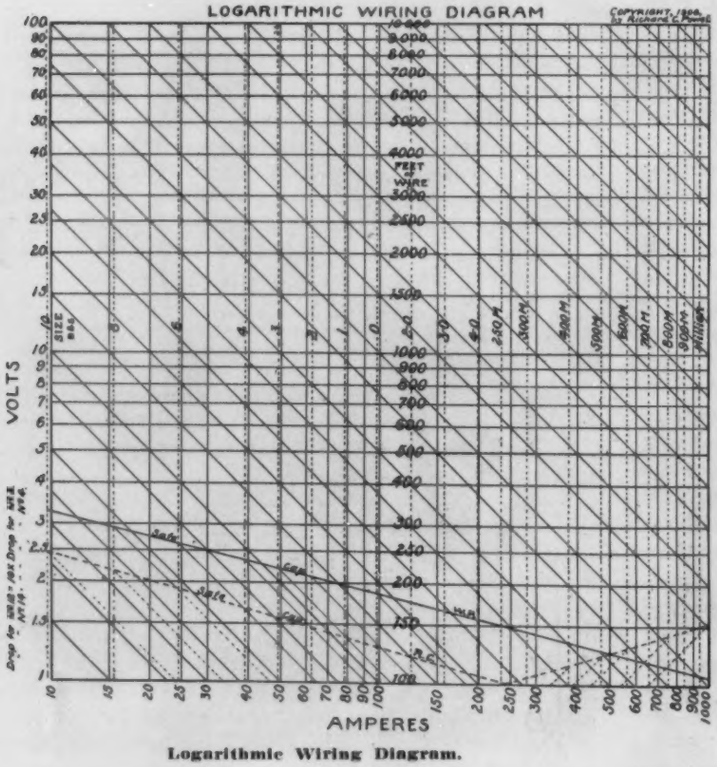
A line AB intersecting, at an angle of 45 degrees, the axes OX and OY of a rectangular system of co-ordinates has the property that the sum of the co-ordinates for any point on it is a constant and equal to the intercepts OA and OB. That is,

$$X_1 + Y_1 = X_2 + Y_2 = OA = OB.$$

Therefore, if on OX we plot values of log V and $\log \frac{C}{10.7}$ and on OY values of log I and log d, and then construct a series of 45 degree lines, we have a graphical means for obtaining any four quantities which will satisfy equation (1).

The constant C has the effect of shifting all the co-ordinates of the variable with which it is associated. Therefore, it is combined with C since the co-ordinates of C as drawn will not, in general, coincide with the co-ordinates of the size, whereas the co-ordinates of volts and distance do.

In the diagram, the full vertical lines give amperes by following to the scale at the bottom. The dotted verticals are marked with the sizes and the full horizontal lines give either volts or distance, in feet of wire, according as one follows to the scale at the left or right.



Logarithmic Wiring Diagram.

From the preceding, it is clear that to obtain the proper relation between the four quantities, it is necessary merely to have the horizontal through "volts" and the vertical through "size" intersect on the same diagonal passing through the intersection of the vertical through "amperes" and the horizontal through "feet of wire." Let us take the diagonal through 200 on the "ampere" scale. The lines through 200 amperes and 100 feet intersect at the foot of this diagonal. Therefore, by following along this diagonal, we find that 100 feet of No. 4-0 wire will give 1 volt drop with this current; No. 0 will give a trifle over 2 volts; No. 1 about 2.5 volts and No. 6 about 8 volts. This also shows quite clearly the well known fact that for a given current and distance a wire three sizes smaller will double the drop.

Thus, the diagram gives, at a glance, the effect of any change in size, distance, amperes and volts drop. Also, with any three of the quantities given the fourth is readily found.

Since the safe carrying capacity of wires can be expressed in a linear logarithmic equation, by adding two straight lines we may extend the diagram to give these quantities. By following the diagonal through the lines "safe cap" and "size" to the "ampere" scale, we obtain the safe carrying capacity for either weather-proof or rubber covered. In the case of rubber covered wire larger than 250M, it is to noticed that the line bends up and the diagonals change direction, as shown by the dotted diagonals in the lower right hand corner.

For example, the safe capacity of No. 4 is 65 amperes for R. C. and 92 amperes for W. P., while for 600M we have 450 amperes for R. C. and 675 amperes for W. P.

Examples: What will be the drop in delivering 80 amperes a distance of 1500 feet, direct current (or single phase, if the effect of induction is neglected), using No. 4 wire?

Trace the vertical through 80 to its intersection with the horizontal through 3000. Then follow an imaginary diagonal through this point to its intersection with the dotted vertical marked 4. Tracing the horizontal through this point we obtain a drop of 60 volts. If, however, a drop of 20 volts is allowed, we find the proper size as follows: From the intersection of 80 and 3000 follow the diagonal to its intersection with the horizontal through 20 volts. The nearest size through this last point is No. 2-0.

What distance will No. 8 carry 25 amperes with a drop of 4 volts?

Find intersection of lines through 4 volts and No. 8. Trace diagonal through this point to intersection with vertical through 25 amperes. The horizontal through this last point is 250. That is, if we have two wires the distance is 125 feet. Neglecting induction, the distance for three phase is 250 feet.

How many amperes can be carried 2000 feet (2 wire direct current) with a drop of 15 volts, using No. 0 wire?

Through the intersection of the 15 volts horizontal and the No. 0 vertical follow diagonal to the 4000 horizontal. Following a vertical through this point, we obtain approximately 38 amperes.

Railroad ties are now being made from Japanese white oak. Several of the western roads have purchased a large quantity to be used in replacing worn out ties along their rights of way. The increasing cost of all railroad ties has naturally led the railroad companies to desire to prolong the life of the species of wood used, by preservative methods, and only recently an application was made to the United States Forest Service to conduct experiments at their Berkeley timber testing station to determine the value and life of the Japanese oak timber when properly treated. This application brought up the interesting point as to whether or not the Forest Service would be allowed to undertake experiments with foreign species of timber, inasmuch as the Act under which these experiments are carried on specifically requires that only American grown timbers shall be treated. The Forest Service has found it necessary, owing to pressure of other work, to decline to undertake this experiment, and therefore this point was not considered.

SUCCESSFUL REGULATION OF HIGHLY FLUCTUATING 60 CYCLE ALTERNATING LOAD.

BY O. W. LILLARD.

The recent installation of a storage battery regulation plant in Elmira, N. Y., is of particular interest to the generating plants of the Pacific Coast, as it is the home of alternating current practice. This was installed in the Madison Avenue Power House of the Elmira Water, Light & Railway Company after several years' consideration of the best method for obtaining the results desired.

This plant supplies a 3 phase, 60 cycle, 2200-volt incandescent service, a. c. arcs, d. c. arcs, a. c. power, 500-volt d. c. 3 wire power, 600-volt d. c. railway and high tension circuits to sub-stations on interurban line. Previous to the recent changes, the d. c. railway load was carried by a separate unit, and the arc and series incandescent lighting loads were carried by d. c. arc generators, belted four to an engine unit.

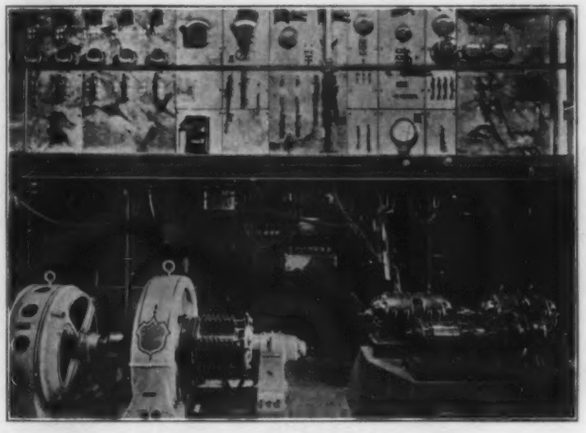
During periods of excessive fluctuations on the high tension and a. c. power lines, it was often found necessary to sectionalize the a. c. bus to avoid voltage fluctuations on the lighting circuits and prevent hunting between the alternators. This method of operation required considerable excess generating capacity, as each unit had to be capable of carrying the peaks of its circuit without help from the other generating units in operation. This proved a very serious trouble in the case of the railway generator, which, though of sufficient capacity to easily carry the average load, would at times be loaded almost to a standstill.

About a year ago, the load on this station increased to such a point that it became necessary to install additional capacity and at this time it was decided to totalize the entire load on the a. c. units; to discard the small engine units driving the arc lighting generators, and hold the d. c. generator as a reserve to be used in case of break down only. The two a. c. units in the station at the time were 750 and 500 k. w., 3 phase, 60 cycle, 2200-volt, also constant current transformers for approximately ½ of the arc circuits, a 300 k. w., 500-volt, three-wire rotary with transformers, and transformers to supply high tension circuits. The new apparatus installed consisted of a 2200 k. w., 3 phase, 60 cycle 2200-volt General Electric turbo-alternator, a 750 k. w., 6 phase, 600 volt shunt wound rotary with transformers, additional high tension transformers and a Gould storage battery of 280 cells, type S-615 in S-623 lead lined tanks, having a discharge capacity of 560 amperes for 1 hour (ultimate capacity when the tanks are filled of 880 amperes for 1 hour), with a regulating booster designed to operate the battery on momentary fluctuations up to three times the one hour rate.

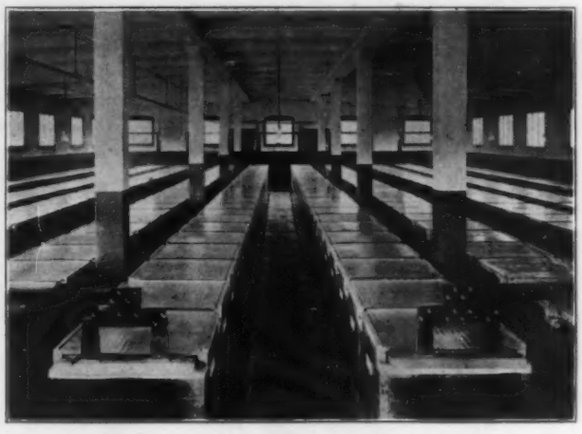
The switchboard was rearranged and the apparatus connected in accordance with the above requirements. Most of the d. c. arc circuits were changed to a. c. constant current systems, but in order to use the d. c. lamps in stock, it was decided to retain two of the d. c. circuits. This was accomplished by connecting two of the arc machines to an induction motor by means of flexible insulated couplings, thus making these two circuits part of the a. c. power load.

The regulating booster system installed in connection with the storage battery is novel, inasmuch as the battery charge and discharge are in accordance with the true energy component of the current in the 60 cycle a. c. circuit. To properly meet operating conditions it was necessary to place the series transformers controlling the booster set in the totalized "variable load" bus connection. This allows the battery to absorb the fluctuations of the variable load but makes the action of same independent of the lighting peak. This feature is very desirable in a plant of this kind, as it permits the removal of the rapid fluctuations (with their resultant overloading of the machines and poor regulation) with a battery of approximately 1-3 the size that would be required if the lighting peak were to be absorbed. This makes it practical to hold the regulated load constant within the close limits of 4 per cent measured on the true energy basis.

It will be noted that with this equipment, any of the generating units (with exception of the d. c. reserve) can be used to supply power to any of the circuits and that the generators are operated under practically constant load, the battery controlling apparatus being so designed that the "average load" supplied to the variable load bus can be changed at will without interruption of service. This makes it possible to use the net discharge capacity of the battery to



Regulating Equipment for A. C. Load.



Storage Battery and Room.

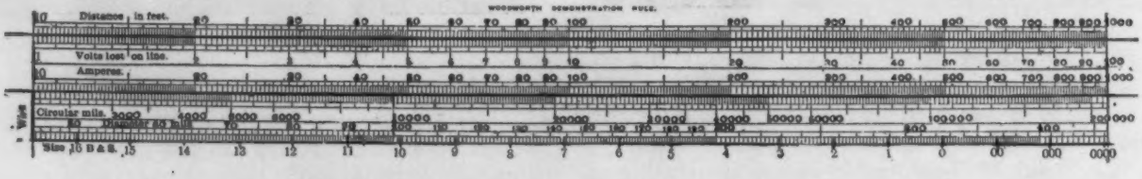
help out the alternators when such is required by simply lowering the average load. When this is done during the periods of light d. c. railway load, the rotary reverts and the battery supplies power directly to the a. c. bus through the rotary.

The advantage or reliability and economy of operation at direct current generating stations carrying highly fluctuating loads, by the use of storage batteries and regulating booster systems are well known. It is, however, of comparatively recent date that battery systems have been used to regulate fluctuating alternating current loads. In the case of the latter the advantages are even greater than in the case of the direct current systems as the close regulation of the true power delivered by the generators prevents changes of load on the prime movers with the resultant speed changes and hunting, thus permitting successful parallel operation where it would otherwise be impossible.

WOODWORTH DEMONSTRATION RULE.

Professor E. P. Woodworth of Lewis Institute, Chicago, has designed a slide rule for wiring calculations for the use of students in electrical engineering as illustrated herewith. On the upper scale is marked distance in feet, the two scales on the slide represent volts lost on the line and current in amperes, respectively, and the bottom of the rule comprises a composite scale, giving areas of wires in circular mils, diameters in mils, and sizes of wire in the B. & S. gauge. Thus the bottom of the rule is really a very compact and useful wiring table. The logarithmic arrangement of the B. & S. gauge is shown by the uniform spacing of the wire sizes on the bottom.

There is given the cross-section of the wire, its diameter and its size, all values corresponding to



American copper-wire practice. The wire scales are related to the upper scales on the basis of 10.7 ohms as the mil-foot resistance of copper. The number of feet per ohm is indicated approximately by the number of circular mils less one cipher. The two upper scales can be used for ordinary multiplication and division. Otherwise the rule is free from auxiliary mathematical scales.

The rule as shown is made up in pocket size of six-inch length. It is printed on bristol board, and can be readily mounted and shellacked. The bristol board itself may be folded so as to make a handy rule. While these rules are not claimed to be highly accurate, they have been found a very convenient practical working tool. Anyone sending his name and address to Lewis Institute will be furnished a copy of the rule shown, with the compliments of Professor Woodworth and of Lewis Institute. This rule is also made in standard slide-rule length.

LOCATION OF POLES AND WIRES.

BY EMERSON W. READ.

There is one primary principle underlying the use of public highways by individuals or companies, alike, which, if duly and sincerely regarded, would prevent any question of right of use by public service companies from arising. To use the language of the Alabama Code, it is, "such lines shall be so constructed and maintained as not to obstruct or hinder the usual travel on such highway." The ordinary use of public highways is the essence of all considerations involving encroachments upon public thoroughfares for extraordinary purposes. This "ordinary use" is a subtle quantity and has been adjudicated upon in numerous appellate courts. Such expressions as "in no way to interfere with the safety and convenience of persons traveling," "common use," "not to interfere with repairs or public convenience in traveling," have been used to define it. If we follow the common law we can safely say that we are not encroaching upon the ordinary use if we do not obstruct the "use for which the highway was intended." Yet, even in this, remains the subtlety that was encountered before.

To obstruct the roadbed proper is no more obstruction of the highway than it is to interfere with the gutterway or sidewalk. As much is the gutter a part of the highway as is the bed proper, and it is so held. Poles planted and based in a gutter are not disallowed. It is possible to place them there and retain the free action of the gutter, but should interference be had with the operation of the gutter, then the poles become nuisances, interfering with the highway's ordinary use.

Persons using the highways can expect, by operation of law, the exercise of reasonable care by the company in erecting poles and wires, to the end that travelers be protected from injury from poles and wires while lawfully in the thoroughfare. In erecting poles and wires the company must take notice of prevailing conditions. What would be reasonable care in one instance would not suffice in others. As an instance, an insulater used in a sheltered valley with complete safety might not be adapted for use on a coast where heavy winds are usual at certain periods in the year. In other words, the equipment must be sufficiently strong to withstand usual conditions. "The poles must be strong enough to withstand such storms as may be reasonably expected, but they are not required to be so strong that no storms can break them, or to withstand such storms as reasonable foresight could not anticipate."

The wires may be so strung in elevation that the use and efficiency of a highway is impaired. It is held that individuals are making an ordinary and proper use of the highway in driving traction engines, tall

loads of hay and lumber, and like things, over them. While the law will not require wires to be so strung as to be elevated (that is, in the absence of statutes and ordinances) above exceptionally tall loads of hay or lumber, yet, reasonable loads are entitled to have free and safe passage. Especially at points where wires cross highways may interference be anticipated.

This proper elevation of wires and cross-arms has been determined in many statutes and "statutory elevation" is now recognized as an established thing. Such regulation is unquestionably a reasonable exercise of the police power, nor does the State or municipality part with such control by granting a franchise to a company thereby authorizing the erection of poles and wires on highways and streets. The State cannot grant away its right and duty to exercise the police power; consequently, the granting of a franchise to erect wires and poles cannot operate to divest the government of its duty to protect life and property by enforcing regulations as to construction and quality of work on public highways. As instances of such regulation,

1. Nebraska requires "telephone poles must be set at least six feet within the boundaries of the roadway and placed so as not to interfere with road crossings, while wires are to be placed not less than twelve feet above all road crossings";

2. Virginia requires "poles must rise at least twenty-three feet over road crossings and twenty-three feet over railroad crossings";

3. Ohio (perhaps the regulations of that State are as specific as any) requires "where the line is built over the track of a steam railroad, poles must be twelve inches in diameter at the bottom and six inches in diameter at the top, and set in the earth not less than one-sixth of their length and well tamped. Double cross-arms are to be used, and wires must be insulated with glass or porcelain insulators and securely fastened to both cross-arms. All wires are to clear the tops of rails at least twenty-five feet, except trolley wire crossings, where the height is to be agreed upon. Where there is any side strain poles must be well guyed or braced."

These are only instances of the regulations common to the States generally. California has enacted provisions, not so much of regulations and restriction, as for protection to companies, as will appear from the following sections quoted:

"Telegraph or telephone corporations may construct lines of telegraph or telephone lines along and upon any public road or highway, along or across any of the waters or lands within this State, and may erect poles, piers, posts or abutments for supporting the insulators, wires and other necessary fixtures of their lines, in such manner and at such points as not to incommode the public use of the road or highway or interrupt the navigation of the waters."

"Any person who injures or destroys, through want of proper care, any necessary or useful fixture of any telegraph or telephone company, is liable to the corporation for all damages sustained thereby. Any vessel which, by dragging its anchor, or otherwise, breaks, injures or destroys the subaqueous cable of a telegraph or telephone corporation, subjects its owner to the damages hereinbefore specified."

"Any person who willfully and maliciously does any injury to any telegraph or telephone property, mentioned in the preceding section, is liable to the corporation for one hundred times the amount of actual damages sustained thereby, to be recovered in any court of competent jurisdiction."

"No telegraph or telephone corporation can recover damages for the breaking or injury of any subaqueous telegraph or telephone cable, unless such corporation has previously erected on either bank of the waters under which the cable is placed, a monument, indicating the place where the cable lies, and publishes for one month in some newspaper most likely to give notice to navigators, a notice giving a description and the purposes of the monuments, and the general course, landings, and termini of the cable."

The record consumption of copper in the United States was 685,000,000 pounds in 1906. The largest exports ever made were those of 650,144,320 pounds in 1908. The maximum figures of domestic and foreign demand combined make a total of 1,335,144,320 pounds. According to the producers' figures for March, 1909, the United States production from domestic and foreign sources, based on the output for that month, was at the rate of 1,404,703,932 pounds a year. If, therefore, United States consumption and exports could possibly be stimulated to the record breaking rate they would still fall short by more than 69,000,000 pounds of the amount produced in this country from domestic and foreign sources at the rate attained last month. Then there was a stock of 182,279,902 pounds in this country on April 1, and 98,232,960 pounds in England and France on same date, making known stocks, here and abroad, of 280,512,862 pounds. A surplus of this size, and a record production, contemporaneously with restricted consumption, furnishes sufficient explanation as to the hard fight the market for copper has to hold its own even at present prices.

Wood Preservation is improved by removing all patches of inner bark so as to facilitate proper penetration of preservatives. In conducting some tests on the treatment of pine in Louisiana and Alabama, in 1907 and 1908, it was noticed by a representative of the Forest Service that very little or no creosote entered the wood through even the thinnest layer of adhering bark. In the creosote treatment of timbers, it is rarely that the entire stick is penetrated by the preservative. The value of the treatment consists largely in the creating of an exterior antiseptic zone around the untreated interior portion. If this outer zone be broken, the value of the treatment is to a large extent lost. In the case of piling, the effect of any small portion of untreated wood extending from the outer surface to the interior of the pile is especially injurious, because of the manner in which teredos work. The teredo enters the wood when small, making but a tiny hole, perhaps no larger than a pinhead. As they grow, they increase the size of their borings, and if present in large numbers, they will very quickly so riddle and weaken a pile, that it will break off with a very slight strain. Access to the interior of a treated pile might readily be gained through small untreated portions of the outer surface of the wood, which, because of bark adhering at time of treatment, absorbed no preservative, with the result that all of the interior untreated portion would be riddled, leaving only the exterior creosoted shell sound.

JOURNAL OF ELECTRICITY
POWER AND GAS

PUBLISHED WEEKLY BY THE

Technical Publishing Company

E. B. STRONG, President
E. M. SCRIBNER, Vice-President and General Manager
A. H. HALLORAN, Secretary and Managing Editor

DIRECTORS

R. J. DAVIS A. M. HUNT E. M. SCRIBNER C. L. CORY E. B. STRONG

604 MISSION STREET, SAN FRANCISCO.

TELEPHONE . . . . . KEARNY 918

TERMS OF SUBSCRIPTION

United States, Cuba and Mexico	per year,	$2.50
Dominion of Canada	"	3.50
Other Foreign Countries within the Postal Union	"	4.00
Single Copies, Current Month	each	.10
Single Copies, prior to Current Month	"	.25

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Electrical Safety Valves

In the early development of high tension transmission of electric power, considerable damage was done to apparatus by lightning discharges and unbalanced line conditions. Investigation as to the cause of this showed that lightning and high-frequency electric currents are identical. Consequently the term lightning is now applied to any phenomena due to abnormal voltage or frequency. Various methods are in use to minimize the damage caused by these discharges. Such protective devices are classified according to their action as either intermittent or continuous. In the first class is the horn type, which is essentially a single break to the ground, and the multi-gap arrester, which consists of a series of shunted gaps between non-arcing metal terminals. The first of these not only arrests the lightning, but also stops the entire system. The second is self-restoring after a single discharge, but is rendered inoperative by recurrent surges.

As distinguished from these intermittent arresters are the continuous devices, which act much like leaky safety valves in dissipating any voltage in excess of the normal. They offer a high resistance up to a critical voltage, above which the resistance is greatly lessened. In this latter type are those which use a jet of water to carry the leakage current, and also the electrolytic aluminum cell which is described elsewhere in this issue by Mr. A. G. Jones. This type short-circuits the excess voltage, but in so doing consumes a small amount of power which at times becomes great enough to seriously overheat the device. It is ordinarily installed at station bus-bars and used as an auxiliary check valve to the multi-gap or horn arrester. It forms the latest, but probably not the last word in lightning protection.

These methods for taking care of potential accumulation are alleviative rather than preventive. They are accident, rather than life insurance policies. In addition there should always be some form of line protection such as an auxiliary parallel or overhead grounded iron wire to withstand atmospheric lightning. While it is expensive to install such a system experience has shown that the outlay is well warranted by the subsequent safety effected. The internal surges are usually caused by an arc produced by switching or accidental short circuit, but besides these operative causes they may be due to faulty design or construction. The subject is one that requires constant vigilance and is illustrative of the "ounce of prevention worth a pound of cure."

CURRENT COMMENT

Storage batteries on street cars are to be tried by the Third Avenue Railroad Company in New York City, who will employ Edison nickel iron batteries. The line is three miles long and the installation is experimental.

The removal of rust from the iron bars of reinforced concrete is due to the reaction between the acid carbonate and sulphate in the cement and the oxide of iron. According to some recent investigations of Rohland, this takes place while the cement is setting.

Electro deposited copper tubes failed under the high steam pressure and temperature employed on the Lusitania. The pipe failed after one year's use, although it had been hydraulically tested up to twice the pressure of its working load of 195 pounds per square inch.

An electric hardening furnace described before a number of European societies and recently placed on the market by the General Electric Company consists of a crucible containing fused potassium and barium chloride. By varying the proportion of these salts definite temperatures up to 1400° C. may be had. Alternating current is used at 70 volts. The steel to be hardened is placed in the fused salts.

An electric ferry on the Rhine has been in successful operation for nearly a year between Godesberg and Niederdollendorf. It is driven by two 50 h. p. motors taking current at 300 volts from a 160 cell storage battery. The capacity is 335 ampere-hours on a one-hour discharge. The boat has a carrying capacity of 645 passengers, is made of steel with twin screws and a maximum speed of 7½ miles per hour.

Aluminum from clay has been produced in the electric furnace by Moldenhauer by treating a mixture of clay, hematite and coal. The reaction first produces ferro-silicon and fused alumina. This mixture is crushed and the alumna separated from the ferro-silicon by an electrico magnetic separator and then treated in a cryolite bath, yielding 70 per cent of metallic aluminum, with a valuable by-product in the ferro-silicon.

Investigation of water powers outside of national forests which are not included within withdrawals for reclamation purposes is to be undertaken by the United States Geological Survey. The findings are to be reported by Secretary of the Interior Ballinger to Congress, coupled with recommendations for legislation to control and regulate the disposition of power sites. The purpose is to prevent monopolistic or speculative interests from securing control of water power sites.

Nitrogen from the atmosphere is obtained by F. Beck by a new process, in which the nitrogen is passed through a molten alloy of magnesium and tin, the magnesium being charged to the nitrite, which is treated with steam to produce ammonia and magnesium oxide. The tin is recovered, and the magnesium oxide dissolved in melted carballite to be used as an electrolyte with a carbon anode and a molten tin cathode. By this process magnesium is formed at the cathode and unites with the tin, the process thus being continuous.

Colombian coal fields are well placed to take advantage of the markets which will be made available by the opening of the Panama Canal. There are at present three routes by which the coal can be sent to the canal: (1) From the Rio Hacha and Santa Marta fields to Colon, across the Caribbean Sea, 500 miles; (2) Darien to Colon, 300 miles; (3) Buenaventura, on the Pacific, to Panama, 400 miles. When the mouth of the Magdalena is opened for steamers and the navigation of the river improved coal may be exported by this additional route. The country has valuable coal fields, almost untouched and little explored, the mines that have been opened being worked in a very superficial way; the unsettled conditions which have prevailed in the republic having halted progress in this connection. No geological survey has ever been made of the Colombian coal fields.

A shorter cable to England is planned by the Commercial Cable Company of New York. It is proposed to cut one of this company's five transatlantic cables at the Flemish Cap, 300 miles east of Newfoundland, and to attach to the European end a new cable running to St. Johns, Newfoundland, and thence to New York City. It is expected that this redivision of the line between New York and Ireland will increase the speed of transmission by 35 per cent. This change has been made possible by the expiration of the exclusive rights of the Anglo-American Cable Company to land cable in Newfoundland. Some 1,700 miles of new cable will be laid if this plan is carried out and the 900 miles between the Flemish Cap and Canso, Canada, will be recovered and resheathed for use elsewhere.

Mexican governmental ownership of public utilities is rumored. The Federal Government is said to be looking into the practicability of acquiring 51 per cent of the stock of the Tramways Company and the Mexico Light and Power Company and operating them as the National Railways of Mexico are now operated. According to the reports, the project of the government is aimed directly at securing the public utilties for the sole purpose of benefiting the public at large and to create the most efficient service. President Diaz is said to favor the accomplishment of the idea, as it would carry out more completely his belief in public ownership and give the country the chance to at once forge ahead of all others in the important work already begun. It would enable Mexico to carry the problem of government control of public utilities to the stage never contemplated by any other government in the world.

PERSONALS.

M. L. Kohler of Philadelphia, Pa., has been elected president of the Chicago Mica Company of Chicago, Ill.

P. J. Aaron, manager of the Seattle office of the Western Electric Company, spent a part of the past week in San Francisco.

Rudolph W. Van Norden has moved his offices from the Mutual Savings Bank Building to 409, 413 Union Trust Building, San Francisco.

H. R. Noack of the San Francisco office of Pierson, Roeding & Company, has returned from an extended business trip throughout the East.

E. N. Fobes, president of the Fobes Supply Company of Seattle and Portland, is in San Francisco after spending a week of recuperation at Del Monte.

Geo. A. Scoville, manager on the Pacific Coast for the Dean Electric Company, at San Francisco, left for a trip through the Northwest on April 26th.

P. L. Hoadley has charge of the Seattle office recently opened in the Central Building by the Sterling Electric Manufacturing Company of Warren, Ohio.

H. B. Vanzwoll, secretary of the Sunbeam Incandescent Lamp Company of Chicago, has been spending the past week or two in Southern California and is now in San Francisco.

Mr. E. M. Latham, purchasing agent of the Pacific Light & Power Company of Los Angeles, spent the early part of the past week in San Francisco in the interest of his company.

William Coale of the Sterling Electric Manufacturing Company, Warren, O., manufacturers of the Sterling incandescent lamp, is in San Francisco accompanied by Mrs. Coale.

E. J. Koppitz, formerly sales engineer with the San Francisco office of the Western Electric Company, has joined the sales force of the San Francisco office of Fairbanks, Morse & Co.

Robert Kuhn of the American Electrical Heating Company, Detroit, Mich., left for the Northwest on Thursday night. Mr. Kuhn formed many friendships during his brief visit and his next trip to the Coast will be looked forward to with interest.

Theodore E. Burger, assistant manager of the California Electric Company, the Los Angeles branch of the Western Electric Company has been appointed manager succeeding Richard Spencer, former manager, who about six months ago was compelled to discontinue work owing to ill health.

OBITUARY.

John Chamberlin Fish, president of the National Electric Lamp Association and of the Shelby Electric Company, died April 16, after an illness of only four days. Mr. Fish was born in Sheldon, Vt., on April 14, 1864. Mr. Fish at the time of his death, aside from being interested in the electrical business, was president of the following companies: The Shelby Printing Company, the Shelby Water Company, the Ohio Seamless Tube Company and the Auto Call System Company, as well as vice president of the Shelby Telephone Company and a director in the Citizens' Bank—all of these being located in Shelby. Aside from endeavoring to benefit his place of residence in business ways, Mr. Fish also devoted a great deal of his time to the intellectual side, being president of the Board of Education. Mr. Fish was a member of the Knights of Pythias and Elk lodges and was president of the Colonial Club, of Shelby, and the Shelby Businessmen's Association. He is survived by a widow and three sons, DeForest R., Cortez Carlisle and John C., and by his mother and one sister, with whom every one who has met Mr. Fish sympathizes in their affliction.

BOOK REVIEWS.

Law and Business of Engineering and Contracting. By C. E. Fowler; 162 pages, 6x9, numerous forms and blanks. McGraw Publishing Co., New York, and Technical Book Shop, San Francisco. Price, $3.00.

This author is best known by his work on "Ordinary Foundations." His wide experience in all parts of the country has eminently fitted him to give advice to young engineers. Older men, also, will find in it many worthy suggestions. After an introductory essay on the relation between the engineer and the contractor he takes up ordinary and special forms of contracts and specifications for various kinds of civil engineering work, illustrating his text with desirable forms and blanks. Valuable hints are contained in the chapters on the inspection of engineering work and estimating materials; likewise in that on bidding. Another chapter deals with organization of contract work and the concluding one gives a synopsis of the law of contracts.

Shop Tests on Electric Car Equipment. By Eugent C. Parham and John C. Shedd; 121 pages, 5x7½ inches, 55 diagrams. McGraw Publishing Company, New York, and Technical Book Shop, San Francisco. Price, $1.00.

The practical nature of this book is indicated by the refreshingly abrupt manner in which the authors get right to business, no historical summary or theoretical abstractions, but a plain explanation of how to do it. The first chapter deals with measurement of current, the second with measurement of voltage and the third with measurement of resistence. The methods given require instruments and other facilities that may be obtainable in a car house. Home-made outfits are described in detail. Succeeding chapters are concerned with high voltage insulation tests and armature tests, and conclude with directions for reviving shocked persons and relieving burns. The explanations and directions are simple and supplemented by many illustrations and practical directions. The whole is reviewed in a list of nearly 300 questions at the close of the volume.

TRADE CATALOGUES.

A neat postal from the Western Electric Company presents a graphic comparison of the advantages of the Improved Blue Bell Battery for telephone service.

An attractive catalogue covering fuse and service boxes arranged to take interchangeable conduit fittings, has been issued by the H. W. Johns-Manville Company of New York City.

In Bulletin No. 4656, from the General Electric Company, is described a current transformer for the measurement of large amounts of current; to be used on circuits, the potential of which does not exceed 2,500 volts.

The General Electric Company has issued Bulletin No. 4657, devoted to the subject of Searchlight Projectors for commercial use. This publication contains illustrations and descriptions of projectors of various types and sizes.

TRADE NOTE.

Hughson & Merton of 438 Market street have just completed arrangements for the opening of an electrical department and will act as representatives on the Pacific Coast for a number of eastern manufacturers. They announce that their list will include the Electric Cable Company of Bridgeport, Conn., manufacturers of insulated wires and cables of every description and insulating compound sold under the trade name "Voltax," and the Cleveland Switchboard Company of Cleveland, Ohio, manufacturers of switch and panel boards. This department will be under the management of Mr. Henry E. Payne, whose experience during the past few years in the machinery and electrical business, particularly equips him for this class of work.

THE AIR LIFT PUMP.

SAN FRANCISCO No. 1, N. A. S. E., listened to an interesting lecture on the subject of "The Air Life Pump" at their meeting of April 18th, by Mr. Sam Skelly, of Alameda, Cal. Mr. Skelly gave an informal talk, basing his remarks on the results of recent experiments and of a varied experience with the apparatus described.

He stated that the utility of the air lift for handling water is most evident where a number of wells are to be operated at some distance from each other, or from a central plant, and where large quantities of water are to be brought to the surface or water impregnated with mud or sand are to be pumped; these conditions making steam or power driven pumping machinery expensive to install, uneconomical in operation and costly as to maintenance. In such conditions the air compressor can be cheaply substituted for numerous pumping heads, and the air piped to the various wells at small expense. The air lift, if properly installed, will work satisfactorily with practically no attention, requires no repairs and will handle dirty water that would ruin a pump, without trouble or damage to itself.

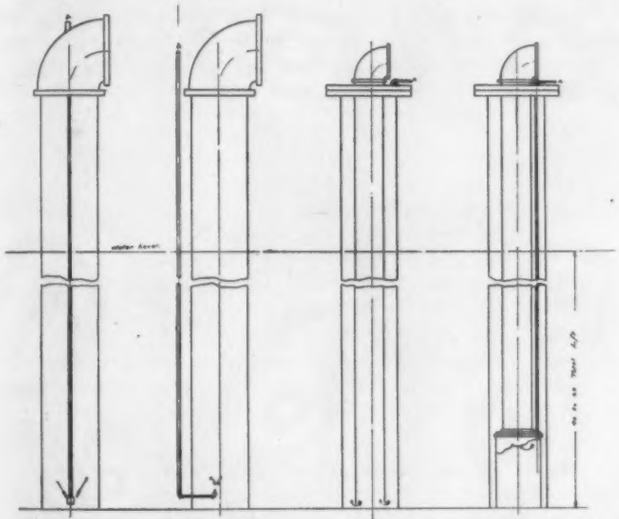


Fig. 1. Fig. 2. Fig. 3. Fig. 4.

The principle of operation of the air lift was simply explained as being the creation of an effective head between two columns of water by lessening the destiny of the discharge column with the introduction of air intimately mixed in the ascending column. In order that this head shall be practically effective there must be a degree of submergence proportional to the proposed lift. This was stated to be about 60 per cent for a reasonable efficiency. Under such conditions as high as 75 per cent efficiency has been attained. When the quantity of water raised is greater than the supply, causing a reduction of level and less submergence, the efficiency decreases rapidly, approximately as the cube of the distance of drop of water level. Greater submergence than 60 per cent, however, gives no additional advantage and where the depth of water exceeds this the apparatus should be submerged only the necessary depth.

Four main systems of applying the air jet are in use for each of which certain advantages are claimed. They are, as illustrated, as follows: Fig. 1, The upturned jet; Fig. 2, The capped; Fig. 3, The central pipe, and Fig. 4, The design used by the United States to a great extent. Of these the third arrangement shown is the one adopted in the experiments mentioned. No. 1 is inefficient for the reason that the air tends to form a central hollow column and escape without effect on the water. No. 2 is applicable only to screwed casing and has no advantages over the other methods. No. 4 is efficient and is practically the same as No. 3. The air jet is preferably a number of small holes with an area aggregating a little more than the area of the air pipe. These holes should be placed in staggered rows around the circumference of the pipe and inclined upward at about 70 degrees from the horizontal. Fig. 5 is a sketch of an improved jet designed and manufactured by Mr. Skelly, wherein the air is introduced in a film and which gives a constant flow of water.

An empirical rule for determining the size of discharge pipe to use for ordinary purposes is as follows: Provide one square inch area of discharge pipe for each 4 cubic feet of free air capacity of compressor. This rule gives excellent results for the usual conditions found. An air pressure of four atmospheres is found to give best results under the same conditions. The substitution of several small pipes of equal aggregate area instead of one large pipe for the discharge gives better efficiency on account of the fact that the tendency of the air to create a hollow column inside the large pipe is thus overcome. This arrangement is also easier to install on account of the smaller pipe used.

In cases where the discharge is to be in elevated tanks at some distance from the well, it is necessary to carry the

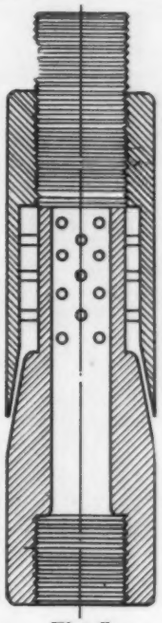


Fig. 5.

discharge directly to the necessary height and then terminate with a horizontal run, or where this is not feasible a stand pipe may be provided to receive the water from the well and otherwise piped to the storage tank.

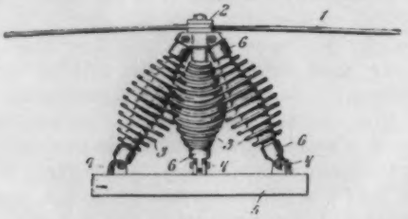
The apparatus will not work satisfactorily with a horizontal run in the discharge below the level to be reached on account of the fact that the air being lighter than the water will separate from the column and leave it dense at the bottom of the pipe.

Under certain conditions a dual system may be installed, using the air lift to bring the water near the surface, and from that point taking it with a suction and lift pump to the tank. The cup at the bottom of the pump suction collects the water from the air lift column, the air passing on upward, providing a continuous supply to pump. This system is applicable to deep wells where the conditions will not permit the use of the air lift alone and where a deep well pump is not advisable.

There are many cases where the use of an air lift instead of a pump is attended with incidental advantages, as when the water is to be used for cooling or condensing purposes. The refrigerant effect of the expanding air being sufficient to lower the temperature of the entire body of water, in some cases as much as twenty degrees.

PATENTS

917,785. Insulating Support for High Tension Conductors. Ralph D. Mershon, New York, N. Y. An insulating support for high tension conductors, comprising a framed structure, for resolving mechanical forces originating in the conductor into



components, having component-resistant members each consisting of an elongated body of insulating material provided with metal connecting caps at its ends.

917,796. Electric Furnace. James H. Reid, Newark N. J. An electric furnace having a plurality of horizontally extending electrodes of different polarity adapted to constitute a

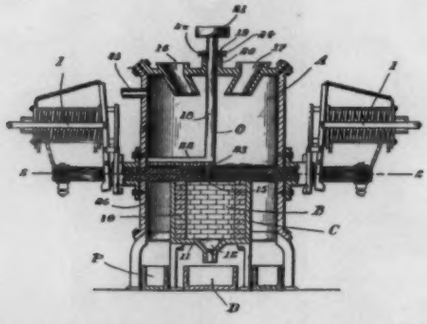
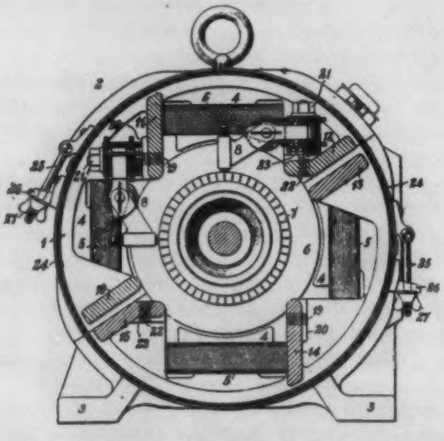


table within the furnace and to produce arcs between, and a sweep adapted to spread the ore on the electrodes and clean it off of the same.

917,806. Electric Motor. Robert Siegfried, Pittsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company. In an electric motor, the combination with a field magnet frame that is open circumferentially at the commutator end

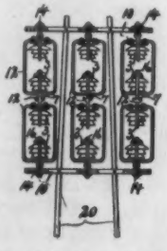


and is provided with brush-supporting ribs, of a two-part cylindrical commutator cover, and means for clamping the cover parts together with their adjacent edges in any desired angular position with reference to the base of the motor.

918,181. Electric Flashlight Attachment. Frederick Meadows, Berkeley, Cal., assignor of one-half to Herbert B. Cornwell, Berkeley, Cal. The combination in a device of the character described, of a two-part separable casing carrying respectively a magnifying lens and terminal contacts, a reflector

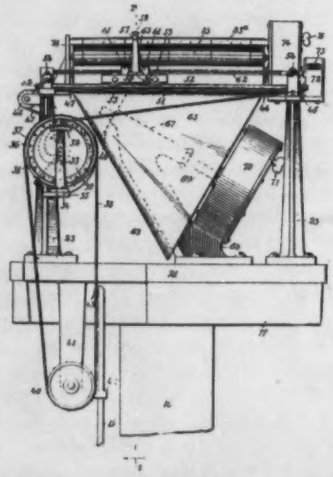
bracket upon opposite ends of which the casing sections are telescoped, an incandescent lamp mounted in the bracket, a conducting finger ring fixed to the casing, an elastic arm concentric, and normally out of contact with the ring, and insulated from the casing, and electric connections through the lamp with the ring and the arm.

918,339. System of Insulation for High Voltage Electric Conductors. Fred M. Locke, Victor, N. Y. A system of insulation for high voltage conductors comprising suitable sup-



ports, and a series of insulators arranged in sequence between the supports, and tie pieces connecting the insulators and supports and exerting compression strains upon the insulators.

918,176. Water Meter. Chris Lory, New Windsor, and Charles A. Lory, Fort Collins, Colo. The combination of a carriage, means controllable by changes in water level, for shifting said carriage into different positions, a revoluble member mounted upon said carriage, a comptometer connected with said revoluble member and actuated thereby,



rollers mounted upon said revoluble member in order to facilitate the travel of the carriage, and a conical driving member engaging said rollers for the purpose of turning said revoluble member.

INDUSTRIAL

GOERIZ CENTRIFUGAL TURBINE PUMPS

BY OSCAR C. GOERIZ.

A novel form of turbine pump has been patented and developed by myself. This pump is so designed that all end thrust is eliminated and is so constructed as to be readily adjusted for efficient working. With regard to the latter point reference to Fig. 1 shows that in a centrifugal pump the discharge openings of the runners "A" must coincide, as closely as possible, with the entrance openings "B" into the diffusion passages. If they should happen to be "out" the pump delivery would be choked to some degree, which would tend to cut down the pump efficiency, in addition to limiting the amount of water handled. When a pump is assembled in the shop, a mark "M" on the shaft calls for a certain length of gauge "D" between a fixed point and this mark, to show that the runners are in proper place. This is a useful innovation to determine from the outside, whether the runners are center to center with the diffusion vanes.

Ring "G" in the position shown in the cut would allow full leakage of the discharge pressure into the chamber formed between the runner tip and suction opening, thus creating a thrust force which acts to the right. Now if this ring

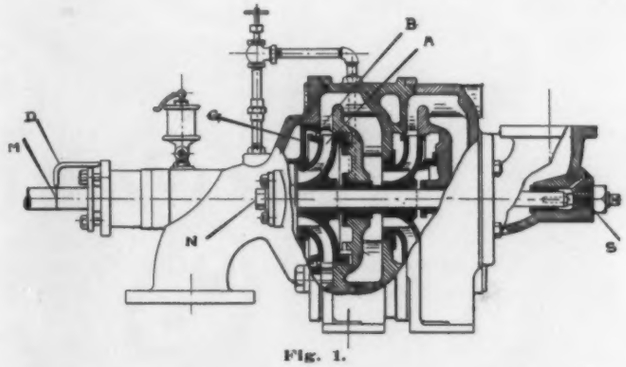


Fig. 1.

"G" is pulled to the left by means of the nuts "N" which operate the ring "G" by studs, or in any other suitable manner, it is evident, and that the leakage will be reduced and finally nearly stopped, and that the pressure in the chamber can be brought down to suction pressure or to a partial vacuum, producing a powerful axial force acting to the left. Any intermediate position of the ring thus creates any axial force between these opposite extremes as determined by areas and possible water pressures. This enables us to balance any axial thrust by means of artificially altered hydraulic opposing forces.

The axial thrust encountered in centrifugal pumps has been a particular source of trouble, because it varies according to the conditions of wear and tear at the various points where leakage takes place, namely the runner tips and wearing rings. Most firms provide heavy collar bearings which not only add to the expense of the construction but also waste energy by mechanical friction and reduce the pump efficiency.

In the construction described here there is provided a temporary step "S" which is only used at the start when adjusting the thrust balancing ring. Experience extending over a lengthy period has shown that the ring must not be touched for a long time after the original adjustment, as it is automatically taking care of the variations of the pump thrust. The gauge "D" shipped with every pump affords an easy means of control and the instruction given to the men simply reads: "If the mark "M" does not coincide with gauge distance "D" shift the ring "G" in the same direction the shaft ought to be moved to bring mark to gauge distance. When shaft and runners are in proper position, ascertained by gauge, the temporary step "S" should be just clear of end of shaft, say 1-16 inch.

Fig. 2 illustrates a vertical 5 inch mine pump of two stage design for 500 gallons per minute to 175 feet total head direct coupled with a Westinghouse electric motor running at 1800 r. p. m. While in such a pump it could be easily arranged to operate the thrust balance ring from the above this was not found to be needed as no readjustment of the ring was required after a number of months running with gritty water. The collar bearing provided for in this pump has simply the purpose of taking care of the revolving weights whenever the pump unit is stopped or started again.

The Risdon Iron Works of San Francisco, which have in addition to many other pumps manufactured the patented pumps

Fig. 2.

listed below, deserve credit for the good workmanship, enabling us not only to attain, but mostly even to exceed the efficiency guarantees.

2 pumps for 125 gallons per minute each, to 240 feet total lift.
1 pump for 500 gallons per minute each, to 75 feet total lift.
1 pump for 400 gallons per minute each, to 75 feet total lift.
2 pumps for 1,100 gallons per minute each, to 300 feet total lift.
1 pump for 800 gallons per minute each, to 75 feet total lift.
1 pump for 4,000 gallons per minute each, to 100 feet total lift.
1 pump for 750 gallons per minute each, to 115 feet total lift.
1 pump for 900 gallons per minute each, to 125 feet total lift.

With the exception of the two pumps mentioned first which are belted, all the other pumps are direct coupled to electric motors. The pump named last in the list has an electric motor placed between the two 2-stage pump halves coupled on either side; with a by-passing pipe arrangement the pump halves working in parallel perform the above duty, while running in series they deliver about 300 gallons per minute to 300 feet pressure for fire service.

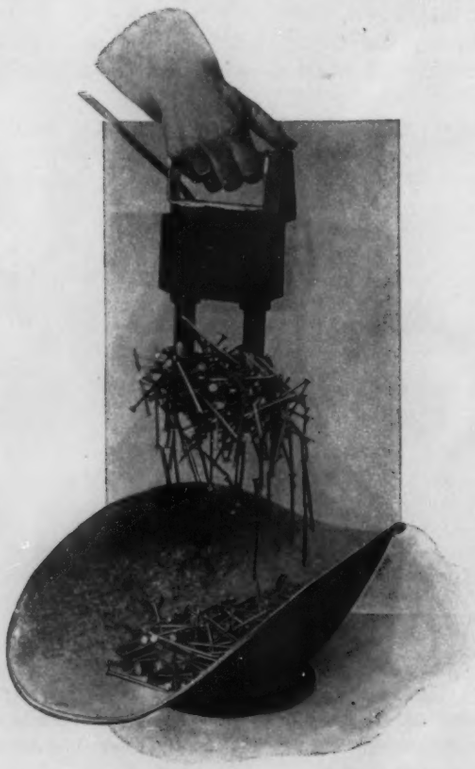
Every year there are a great many patents issued, some of which are never put into practice, and it is therefore very gratifying to the writer that in spite of business depression we are able to publish a list of the patented pumps built or in course of construction, which may prove that a good start has been made to exploit this invention.

A HANDY MAGNET.

Something new in the lifting magnet line has been placed on the Market by the Cutler-Hammer Clutch Company of Milwaukee, whose large lifting magnets are widely used in the iron and steel industries for handling pig iron, scrap, etc. The new device is a hand magnet weighing about 7 pounds, but capable of lifting castings of from ten to fifteen times its own weight.

The magnet is designed for operation on 110-volt direct current circuits and is furnished with drop cord and attachment plug so that it may be readily attached to any ordinary lamp socket. The push-button mounted on top of the magnet and operated by the thumb closes the circuit to the coils and makes the magnet operative. On releasing the button the poles become demagnetized and the load is released.

It seems to be capable of many useful applications. In machine shops it is used for clearing chips and borings out



Cutler Hammer Lifting Magnet.

of the machinery or removing them from parts of the work not easily accessible, as for instance from the bottom of a deep cylindrical casting. Dropped tools, bolts, boring bars, etc., are easily recovered with the aid of the magnet from places from which it would be difficult to fish them my ordinary means.

In shops where large quantities of brass and iron filings accumulate and which it is desirable to separate before selling as waste material, the magnet is especially useful since brass being non-magnetic is not attracted by the magnet, like iron, thus enabling the two metals to be separated by merely passing the magnet through the mixed metals. In the same manner tacks or nails can be separated instantly from brass screws with which they have become accidentally mixed.

In foundries this magnet may be used to pick up hot or awkwardly shaped castings; smooth plates, which are sometimes difficult to secure a hold on when laying on a flat surface, or for cleansing the molding sand of minute particles of metal.

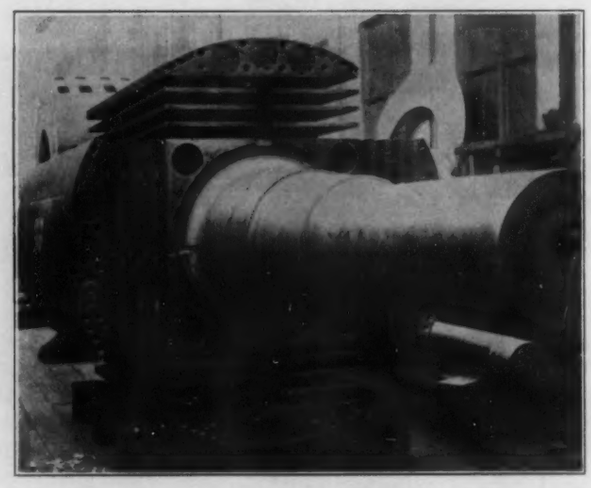
Suspended with its two poles immersed in the liquid. the magnet will attract to itself any particles of iron or steel, which it may be desired to remove from the tubs in which paints, glazes, chemicals, etc., are mixed.

One purchaser, who uses several automobile trucks in his business, has put this magnet to a novel use. He is paving an alley in the rear of his store with ashes and finding that many nails from packing boxes, burned under the boilers, were mixed with the ashes he is now guarding against punctured tires by employing a magnet to remove nails from the ashes before strewing them in the alley.

In the shipping departments of large establishments many hundreds of nails are recovered daily by hand from the sweepings. For work of this sort, or for handling nails, nuts, screws, etc., in hardware stores the little magnet here illustrated should prove useful. Otis & Squires are the San Francisco representatives of the Cutler-Hammer Clutch Company.

WESTINGHOUSE PROGRESS.

The improvement in the business of the Westinghouse Machine Company's shops at East Pittsburg, which has been noticeable for several months, continues in the most encouraging degree. Since the first of April quite a number of orders for steam turbines, steam engines and gas engines have been booked, and the record for the first two weeks of this month shows a considerable increase over the same period



Rotating Field of 15,000 h. p. Turbine Generator Set for City Electric Company.

of March. With the anticipated closing of quite a number of contracts for which negotiations are now pending, the indications are that the April business will make an excellent showing. Among the contracts particularly worth mentioning which the company has lately received is an order from the City Electric Company of San Francisco for a 15,000-horsepower steam turbine. This will be the most powerful steam turbine installed west of the Mississippi, its power capacity being about equal to ten of the largest size express railway locomotives. This company has already installed three Westinghouse steam turbines of a smaller size. The East Pittsburg shops are also turning out at present on order from the City of Detroit a 5000-horsepower steam turbine, and another of the same size is going to Nichols Copper Company of Laurel Hill, Long Island, while the Saginaw & Flint Railway Company of Michigan has contracted for an 1150-horsepower turbine and the Alaska Treadwell Gold Mining Company of San Francisco has ordered two 1000-horsepower machines of the same type.

NEWS NOTES

FINANCIAL.

SIERRA MADRA, CAL.—Bonds, amounting to $30,000, are on sale this week for the erection of a municipal gas plant.

LOS ANGELES, CAL.—Bonds have been issued in this city to the amount of $150,000 for extending the electric light system.

PASADENA, CAL.—The $150,000 municipal lighting bonds issued here were bought this week by the First National Bank of this city.

FRESNO, CAL.—The proposed $1,000,000 bond issue for the Fresno-Hanford Interurban Railroad will be purchased by the Cleveland Construction Company. Over $250,000 is to be spent in wages in the next few months. W. E. Davis of the Cleveland Construction Company is superintending the construction work.

OAKLAND, CAL.—The gross earnings of the San Francisco, Oakland & San Jose Railway Company for March, 1909, show an increase of $500 over March 1908. The net earnings increased $4,000. The official statement for March is as follows:

	1909.	1908.
Gross earnings	$233,992.36	$232,494.35
Operating expenses	32,749.01	38,228.27
Net earnings	$40,416.78	$36,370.46
Fixed charges	23,142.06	20,851.90
Surplus	$17,274.72	$15,518.56

OAKLAND, CAL.—The March, 1909, gross earnings of the Oakland Traction Company show an increase of $1,500 over March, 1908. The net shows a decrease of $6,000, owing to increased operating expenses, caused by the opening of new lines in Berkeley. The statement for March is as follows:

	1909.	1908.
Gross earnings	$233,992.42	$232,494.35
Operating expenses	116,302.42	108,636.01
Net earnings	$117,689.94	$123,858.34
Fixed charges	45,367.28	45,872.41
Surplus	$ 72,322.66	$77,985.93

TRANSMISSION.

EUREKA, CAL.—A. Tinsley has located 10,000 inches of the waters in Campbell Creek, near here, for power purposes.

CITY OF MEXICO, MEX.—Augusta Pellet has applied for the right to use the waters of the Tequesquipan river for generating electric power.

PASADENA, CAL.—The present power house at Mt. Wilson is to be replaced by a modern concrete building with steel roof, and improvements are to be made in its equipment.

SANTA BARBARA, CAL.—Bids will be received by the Santa Barbara (Cal.) City Council up to May 6th for a franchise for the construction of an electric distributing system in the city.

BAKERSFIELD, CAL.—Supeerintendent W. S. Cone, of the Edison Electric Company, states that the Kern River plant is still out of commission and the company is awaiting the arrival of machinery from the East.

SAN FRANCISCO, CAL.—Inspector David Atkins, of the United States Treasury Department, is now in this city superintending the installation of a $40,000 auxiliary power plant to be installed at the United States Mint.

SPOKANE, WASH.—The Spokane-Orient Power Company has been incorporated here with a capital stock of $1,000,000 by C. A. Luncheford, C. H. Patten, A. R. Patten and others. The company proposes to generate electric power on Boulder Creek, where a water-right has been secured, with a fall of 300 feet, capable of developing 2,500 horsepower.

SEATTLE, WASH.—The Entiat Power Company has voted to increase its capital stock from $50,000 to $200,000. The Entiat Company has been at work at the plant at Entiat for some time and has already completed a large dam in the Entiat River, constructed the canal and prepared a site for the power house. It is the intention of the company to put in one of the largest plants in Central Washington.

INCORPORATIONS.

OAKLAND, CAL.—The Electric Equipment Company has been incorporated here by G. F. Bulen, J. G. Wallmann and M. H. Bulen.

SAN FRANCISCO, CAL.—The Gilroy Gas Works has been incorporated here with a capital stock of $50,000 by D. O. Druffel, M. Flaherty and L. P. Lowe.

COALINGA, CAL.—The Pacific States Petroleum Company has been incorporated here with a capital stock of $300,000 by G. W. Richard, E. J. Broberg and Con O'Donnell.

SAN FRANCISCO, CAL.—The Paula Oil Company has been incorporated here with a capital stock of $750,000 by F. L. Brown, C. B. Simmons, C. B. B. Barnes, H. M. Brittan and G. K. Walker.

RED BLUFF, CAL.—The Butte & Tehama Power Company has been incorporated here with a capital stock of $1,000,000 by Luke McDonald, L. A. McIntosh, R. S. Kitrick, J. E. Frick and Leon Bly.

SAN JOSE, CAL.—The Bell Oil Company has been incorporated here with a capital stock of $1,000,000 by E. F. Wayland, C. A. Barlow, J. H. Stewart, H. McFadden, H. E. Bell, B. A. Herrington, P. Taminelli and J. A. McCarley.

MEXICO CITY, MEX.—The Mexican National Gas Company has been incorporated here with a capital stock of $2,500,000. The officers and directors are: President, J. L. Doheny; first vice president, C. A. Canfield; second vice president, R. H. Miner; secretary and treasurer, Norman Bridge; directors, E. P. Ripley, R. O. Bradley, W. L. Hardin and Harold Walker. Offices will be maintained in Los Angeles. The company is now buying its generators, boilers and other equipment.

LOS ANGELES, CAL.—The International Oil Refining Company has been incorporated here with a capital stock of $1,000,000. The new company proposes to build a $100,000 refinery at Thenard Junction, on the inner harbor of San Pedro, where 49 by-products will be manufactured from the California crude oil. The officers of the company are: President, J. Lamb Doty; vice president, F. S. Rishel; secretary and treasurer, G. Holman Coffin Jr.; and directors, Charles Rixon Jr. and Dr. J. Addison Jackson. A right of way for pipe lines to the outer harbor at San Pedro has already been secured.

ILLUMINATION.

AZUSA, CAL.—Bids will be received by the City Council up till June 7th, 1909, for a gas franchise in this city.

COALINGA, CAL.—A. W. Smith and S. H. Hain were granted a franchise this week to construct a gas distributing system in this city.

SAN FRANCISCO, CAL.—The San Francisco Gas & Electric Company, let contracts this week, amounting to nearly $30,000, on their new building at Sutter and Stockton streets.

SACRAMENTO, CAL.—An ordinance has been passed in this city whereby all electric poles in the business district excepting trolley poles, must be removed and wires placed underground.

WASHOUGAL, WASH.—The Western Light & Power Company, under the management of C. W. Cottrell, intends to install a 450 horsepower electric plant on the Washougal river, one mile above Washougal.

FORT BRAGG, CAL.—The Fort Bragg Electric Light Company will enlarge its plant soon in order to keep pace with the growing business. A new dynamo of 750 kilowatt capacity will be installed during the summer.

SAN LUIS OBISPO, CAL.—President W. F. Boardman of the San Luis Gas & Electric Company, announces that four miles of new gas mains are to be installed this summer. The company is also to make several improvements at its generating plant.

MONTEREY, CAL.—Th Monterey County Gas & Electric Company will begin installing soon a new gas plant at its works in this city which will cost $20,000. A transmission line is also to be built to Salinas for lighting and power purposes in that city. This will require an expenditure of over $30,000.

TURLOCK, CAL.—Superintendent Arch Scott, of the La Grange Water & Power Company, has a gang of men at work in this city constructing the new electric light and power system. He states that electric power will be in Turlock in about three weeks. Offices have been opened under the local management of A. S. Hunt.

SEATTLE, WASH.—Steam that has been going to waste in the city incinerator plant at the south end of Lake Union is now being utilized to generate electricity. One 250 horsepower generator has been installed, which furnishes electricity for lighting the incinerating plant, operating and lighting the city asphalt plant and driving a 1,000,000 gallon pump recently installed in the incinerating plant. Plans are being considered to furnish electricity for lamps to nearby buildings.

OAKLAND, CAL.—Manager F. A. Leach Jr., of the Oakland Gas, Light and Heat Company, announced this week a reduction in the Alameda County electric light rates from 9 cents per kilowatt to 4 cents. The rate to be charged for all current for heat will be 3 cents per kilowatt. This cut was made in order to underbid the rates offered the county by Charles L. Pryal, representing the Central Oakland Light & Power Company, who offered to save the county $400 a month.

TRANSPORTATION.

SANTA BARBARA, CAL.—Bids will be received up till June 7th, 1909, for the sale of an electric franchise along certain thoroughfares in the city.

SACRAMENTO, CAL.—The Vallejo & Northern Railway Company has been granted a franchise to operate electric lines on certain thoroughfares in this city.

SANTA BARBARA, CAL.—Bids for the sale of the street railway franchise applied for by the Pacific Improvement Company will be received in this city up till May 6th, 1909.

OAKLAND, CAL.—President F. A. Heron, of the Oakland Traction Company, has announced a reduction to 5 cents on the Leona Heights suburban line between Vernon station and Oakland.

LOS ANGELES, CAL.—The Los Angeles Railway Company is soon to reconstruct its lines on Spring street, between Fifth and Ninth. Crushed rock ballast will be put down and the 60-pound rails now in use will be placed by 70 pound rails.

CHICO, CAL.—The Northern Electric Company is now engaged in reconstructing its Hamilton Branch from this city. Over 2000 feet of track was washed away by the floods of January and the company is pushing the work to completion as rapidly as possible.

OIL.

TONOPAH, NEV.—The Pioneer Water Company has been granted a franchise to lay pipe lines in this city.

ANTIOCH, CAL.—The California Powder Works will building its pumping station in this city, where water will be forced from the river to the works, about four miles away.

LARKSPUR, CAL.—The Wright Water Company of this city has been leased for three years by LeCornec & Larkins. The new management intends to increase the storage capacity of the plant and improve the service generally.

SANTA BARBARA, CAL.—The Union Oil Company has been granted a permit by Acting Secretary Oliver, of the War Department, to build a pipe line from its works at Santa Barbara 2,000 feet into the Pacific Ocean, and to erect a dolphin at the outer end to pump the oil into ships.

WATSONVILLE, CAL.—A valuable oil flow, which has been creating much excitement in this vicinity, was struck this week at the Watsonville Oil Company's site a few miles east of here. The flow, which runs high in gasoline, averages 250 barrels a day and a great quantity of gas is produced.

OAKLAND, CAL.—M. J. Laymance of this city purchased last week for $200,000 oil land in the Mariposa Oil District, near Los Angeles. This property was sold less than three months ago for $150,000. Mr. Laymance has already placed large orders for machinery with Oakland firms, and no time will be lost in establishing a working plant on the field.

TELEPHONE AND TELEGRAPH.

SAN LUIS OBISPO, CAL.—George Jessup, representing the United Wireless Telegraph Company, is now in this city selecting a location for a station. This company has now nearly 30 stations on this coast, the last one being installed at Monterey.

SAN FRANCISCO, CAL.—The Telephone Rates Committee of the Board of Supervisors has passed to print recommendations which will reduce the present income of the Pacific States Telephone & Telegraph Company between $60,000 and $65,000. The committee assured the company of an income of at least 8 per cent upon its invesment. Increases in the number of switches allowed without extra charge were made as follows: Under the $5 a month rate, from 42 to 60 switches; under the $9.15 a month rate, from 125 to 175 switches; under the $12.47 rate, from 209 to 300 switches; under the $15 rate from 292 to 400 switches; under the $17.48 rate, from 500 to 600 switches; under the $19.57 rate, from 667 to 780 switches. A new rate of 25 cents a day was also provided for single telephones with five switches without extra charge, additional switches to be charged for at 4 cents each. A rate was also created of $3 a month for a single party residence line, carrying 125 switches without extra charge, with a charge of 3 cents each for additional switches.